Characterization of Upper Saginaw River Turning Basins as Sediment Traps

Background

Studies conducted in 2004 by Dow (CH2MH), MDEQ, and the U.S. Army Corp of Engineers (USACE) in the Saginaw River identified significantly elevated concentrations of dioxin in the sediments of the Upper Saginaw River, primarily in the non-navigational portion of the river from Green Point to the Sixth Street Turning Basin. Core sampling and congener profiles indicated that the Tittabawassee River is a source of this contamination to the Upper Saginaw River.

In this area of the Upper Saginaw River, two navigational turning basins exist. The Ojibway Island (Ojibway) Turning Basin is located 3 miles south of the confluence with the Tittabawassee River. Ojibway was abandoned over 20 years ago and has an estimated 75,000 cubic yards of sediment. The Sixth Street Turning Basin (Sixth Street), downstream of the City of Saginaw, is the current terminus of commercial navigational dredging, and was recently dredged of approximately 100,000 cubic yards of sediments in October 2006.

The Ojibway and Sixth Street Turning Basins present an opportunity to conduct studies of sediment depositional behavior in the Upper Saginaw River. Rate of settling, composition of settled material, and dioxin contaminant levels, from a historical (buried) and recent (surficial) perspective, are important components for evaluating whether sediment traps could be an effective measure in capturing sediments and associated contamination.

Study Context

A Technical Workgroup with scientists representing numerous state and federal agencies, the Saginaw Chippewa Indian Tribe, and Dow, were assigned the task of designing an initial pilot study in the Saginaw River to answer critical questions concerning the use of sediment traps to capture and remove sediments and associated dioxin and furans.

Under the guidance of the Technical Workgroup, Dow Consultant, ENVIRON International Corporation, drafted, "The Characterization of Sediments in the Ojibway Turning Basin (Study 1)", and "Sediment Trap Field Performance and Feasibility Study in the Saginaw River Sixth Street Turning Basin (Study 2)". The MDEQ, USEPA, and Dow, as well as the state, federal and tribal agencies, serving as trustees for natural resources of the river and bay, supported the proposed studies. Dow has agreed to fund the implementation of these workplans. The two studies will begin in November of this year (2006) and continue through 2007. The studies will incorporate additional information (i.e. geochemistry) that may become available from other studies that are ongoing.

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STUDY 2:

SEDIMENT TRAP FIELD PERFORMANCE AND FEASIBILITY STUDY IN THE SAGINAW RIVER SIXTH STREET TURNING BASIN

SAMPLING AND ANALYSIS PLAN (SAP)

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October 16, 2006

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1. INTRODUCTION

This SAP describes field and supporting laboratory work to identify and assess the feasibility of using sediment traps to collect sediments under different hydrodynamic conditions in the Saginaw River, Michigan. This SAP describes the second of 2 studies scheduled for implementation commencing October-December 2006 through December 2007. The two studies are as follows:

Study #1. Characterization of Sediments in the Ojibway Turning Basin
Study #2. Sediment Trap Performance and Feasibility Study

The primary goal of both studies is to assess the long-term performance and feasibility of a large-scale field sediment trap in the Saginaw River, Michigan (Figure 1, Site Map). The recent (August-September 2006) emergency dredging of the Sixth Street Turning Basin provides a unique opportunity to evaluate the performance and feasibility of a pilot-scale sediment trap in the Saginaw River, while evaluating historical sediment deposits in the historically dredged Ojibway Island Turning Basin.

1.1 STUDY #1 - CHARACTERIZATION OF SEDIMENTS IN THE OJIBWAY TURNING BASIN

The goals of Study #1 are to characterize dioxin/furan (D/F) concentrations in historical sediment deposits and to correlate the distribution of congeners at different depths (if possible) with physical or chemical sediment characteristics, such as particle size distribution (PSD), organic carbon content, black carbon content, bulk density, and/or mineralogy. This study will supplement ongoing geomorphological studies measuring D/F concentrations among different morphological features (e.g., levees, wetlands, floodplain soils, and river terraces) to better understand the distribution of D/F in soil and sediment samples and to correlate (if possible) relationships between D/F concentrations and river morphology.

The study will be conducted in two phases. Phase 1 will include sediment coring, vertical segmenting of sediment cores, analysis of bulk D/F concentrations, and analyses of bulk PSD, organic carbon, black carbon, and mineralogy. Phase 2 will include sediment fractionation studies using a subset of the bulk samples.

Ongoing D/F fractionation protocols developed by Dow's Environmental Chemistry group will be applied to a subset of sediment samples collected during Phase 1. The fractionation analytical approach is currently under development by Dow using floodplain soil samples, and is described in Appendix G of the *Geomorph Sampling and Analysis Plan* (ATS 2006). The approach involves fractionating samples into sand (53-2000 μm), silt (5-53 μm), and clay (<5 μm) size fractions and analyzing those size fractions for D/F, TOC, black carbon, and mineralogy.

The expected outcome of Study #1 includes the following:

- Collection of empirical data on the distribution and capture of D/F in historically deposited sediments at the Ojibway Island turning basin, and an understanding of the

deposition and layering characteristics (e.g., size of particles and mass of contaminants) that a potential sediment trap may exhibit in the Upper Saginaw River over time.
- Assessment of how D/F congener distributions and total D/F concentrations in sediment deposits may have changed over the past 20 years.
- Characterization of the morphological distribution of deposited sediments, including grain size and organ carbon content, and a comparison of these morphological characteristics with other reaches of the river based on the *GeoMorph* results.
- Application of D/F fractionation methods to river sediments by Dow's Environmental Chemistry Group to better understand D/F distribution based on sediment grain size and sediment morphology, develop a better understanding of mechanistic sorption processes, and quantify desorption rates.

1.2 STUDY #2 - SEDIMENT TRAP PERFORMANCE AND FEASIBILITY STUDY

The goal of Study #2 is to implement a mass balance evaluation by measuring river transport velocities, cross sectional areas, suspended solids loads, and D/F concentrations on the suspended solids under a variety of flow conditions, including low and high flow periods that occur during different seasons. A simplified conceptual model of the sediment mass balance study is shown in Figure 2 (conceptual diagram). The conceptual model also should recognize varying solids loads, sediment deposition, burial, resuspension, and transport rates in the Saginaw River as distinct elements of the mass balance. Though not illustrated in Figure 2, the conceptual model also should recognize the dynamic nature of the mass balance based on dynamic flow and solids transport conditions. Flows and solids loads will differ during the rising limb and the falling limb of a wet weather event, for example.

Several measurement techniques will be used to establish flow velocities and suspended solids concentrations in the river. The mass balance study will be supplemented by bathymetry measurements and surface sediment sample collection in the turning basin sediment trap to measure sediment accumulation in the trap over time. A preliminary mass balance study will be conducted at the existing Sixth Street Turning Basin, which underwent limited emergency dredging in August-September 2006.

The expected outcome of Study #2 includes the following:
- Measurement of sediment and D/F mass entering and exiting a pilot-scale sediment trap.
- Quantification of sediment and D/F mass deposition in a pilot-scale sediment trap.
- Assessment of the feasibility of a pilot-scale sediment trap to capture and trap suspended solids and D/F mass in a dredged turning basin.
- Collection of information needed to scale up and design a full-scale sediment trap for long-term river maintenance.

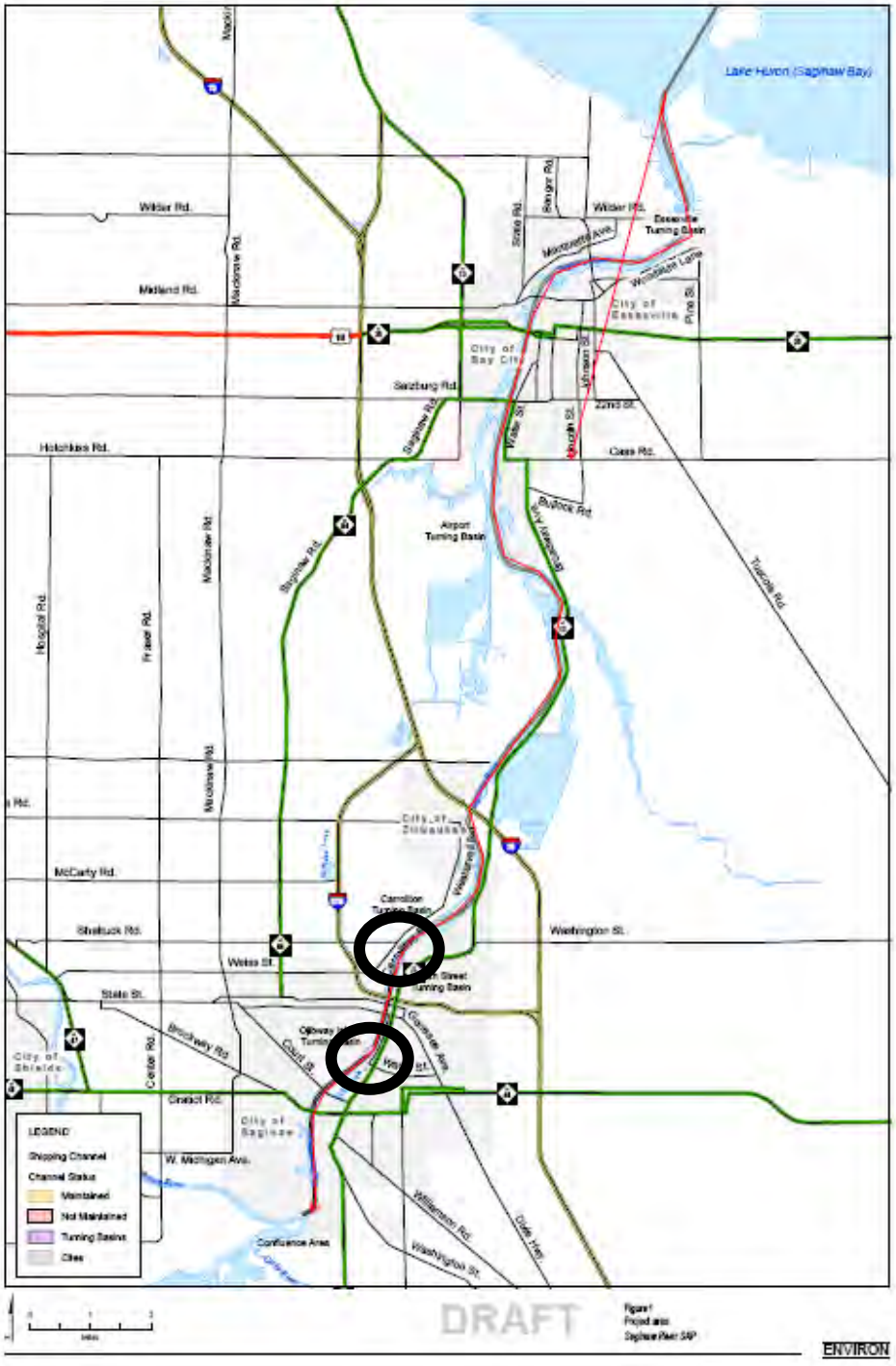

Figure 1. Locations of the Sixth St. Turning Basin (SSTB) and Ojibway Island Turning Basin along the Saginaw River in the vicinity of the City of Saginaw, MI.

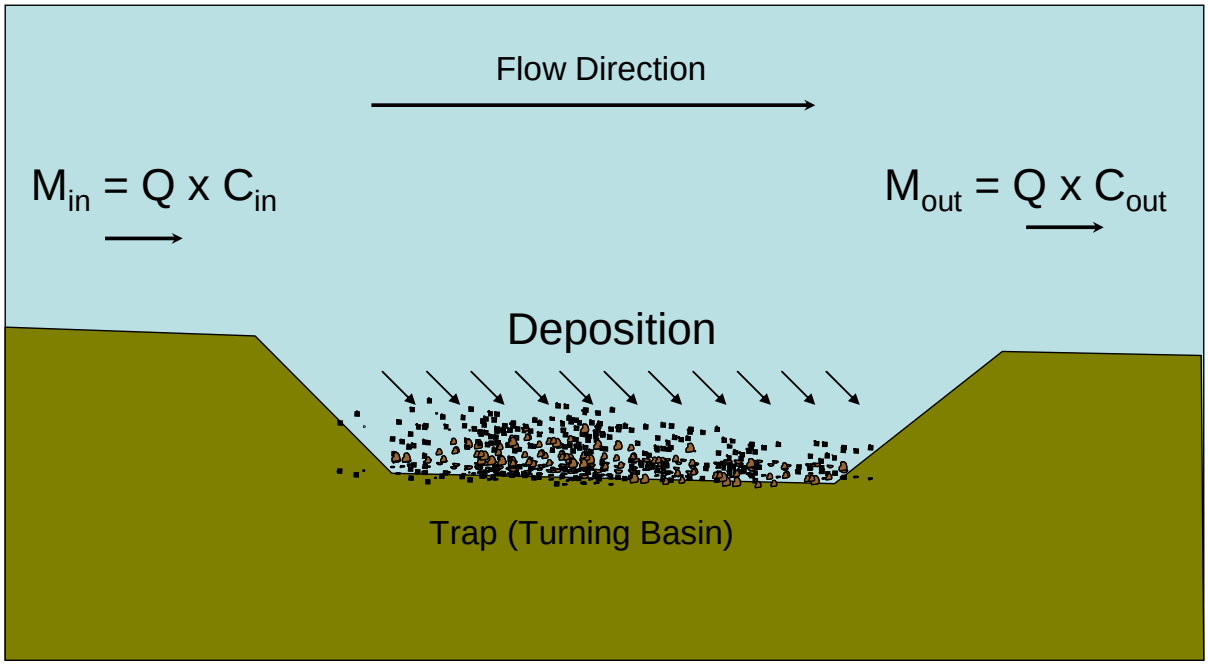

Figure 2. Sediment Mass Balance Study Conceptual Model.

2. STUDY #2 OVERVIEW

2.1 DESCRIPTION OF STUDY AREA

The sediment trap performance and feasibility study will be conducted at the Sixth Street Turning Basin (SSTB), which was dredged in August and September 2006 by the US Army Corps of Engineers (USACE). The SSTB is shown in a 1987 plan view of the turning basin in Figure 3 (SSTB map). The SSTB is located in the navigational channel of the Upper Saginaw River, approximately 5 miles south of the confluence of the Tittabawassee and Shiawassee Rivers (Green Point), located at river mile 17.5 from the mouth of Saginaw Bay.

2.2 OVERVIEW OF FIELD ACTIVITIES

The field work described in this SAP addresses 3 types of hydrodynamic surveys (a short-term dry weather survey, short-term wet weather surveys, and a long-term survey). Each type of survey will be conducted at locations situated both upstream and downstream of the SSTB to monitor solids loads entering and exiting the turning basin, and to assess the feasibility of the turning basin to trap sediment solids and D/F mass. The surveys are intended to collect relevant information on river conditions during low and high water flow conditions

Each hydrodynamic survey will collect water level, current velocity, and water quality data for input to a sediment transport study and for evaluation of SSTB sediment trap performance and feasibility. The oceanographic field team will deploy and recover a suite of in-situ recording instruments, which will document the surface water elevations, current velocity, suspended sediment load, and suspended solids distribution the Saginaw River, upstream and downstream

of the SSTB. Additional characterization data (i.e., temperature, pH, and dissolved oxygen levels) will be collected for general characterization of river water quality.

Three short-term hydrodynamic surveys will include 1 dry weather survey (scheduled for fall 2006) and 2 wet weather surveys (scheduled for spring 2007). The purpose of the short-term surveys is to collect detailed information on D/F sediment concentrations, river flow conditions, and particle distributions to support analysis of mass flux entering and exiting the turning basin under both low-flow and high-flow conditions, and to estimate the mass retained in the turning basin under these conditions. Short-term survey results are intended to characterize the cross-sectional heterogeneity of measured parameters in the river.

One long-term hydrodynamic survey is intended to provide information on flow and solids variability over time, accounting for spring/summer variability in sediment load and transport characteristics. The long-term survey involves placing in-situ instrumentation placed in the river to monitor velocity and suspended solids over extended time periods (in this case, approximately 3 months). The long-term survey will be conducted between spring and fall 2007, commencing during spring thaw to capture high flow conditions in spring and the subsequent reductions in flow conditions as conditions progress towards a summer river flow regime. The study will continue until low, dry weather flow conditions are achieved to monitor the transition from high to low flow conditions. All equipment will be removed from the river before winter 2007.

Four tasks have been identified for this study and are discussed in Section 4.0. . The 4 tasks planned for the field investigation are:

- Task 1 – Establish monitoring transects
- Task 2 – Short-term hydrodynamic surveys
- Task 3 – Long-term hydrodynamic survey
- Task 4 – Bathymetric surveys

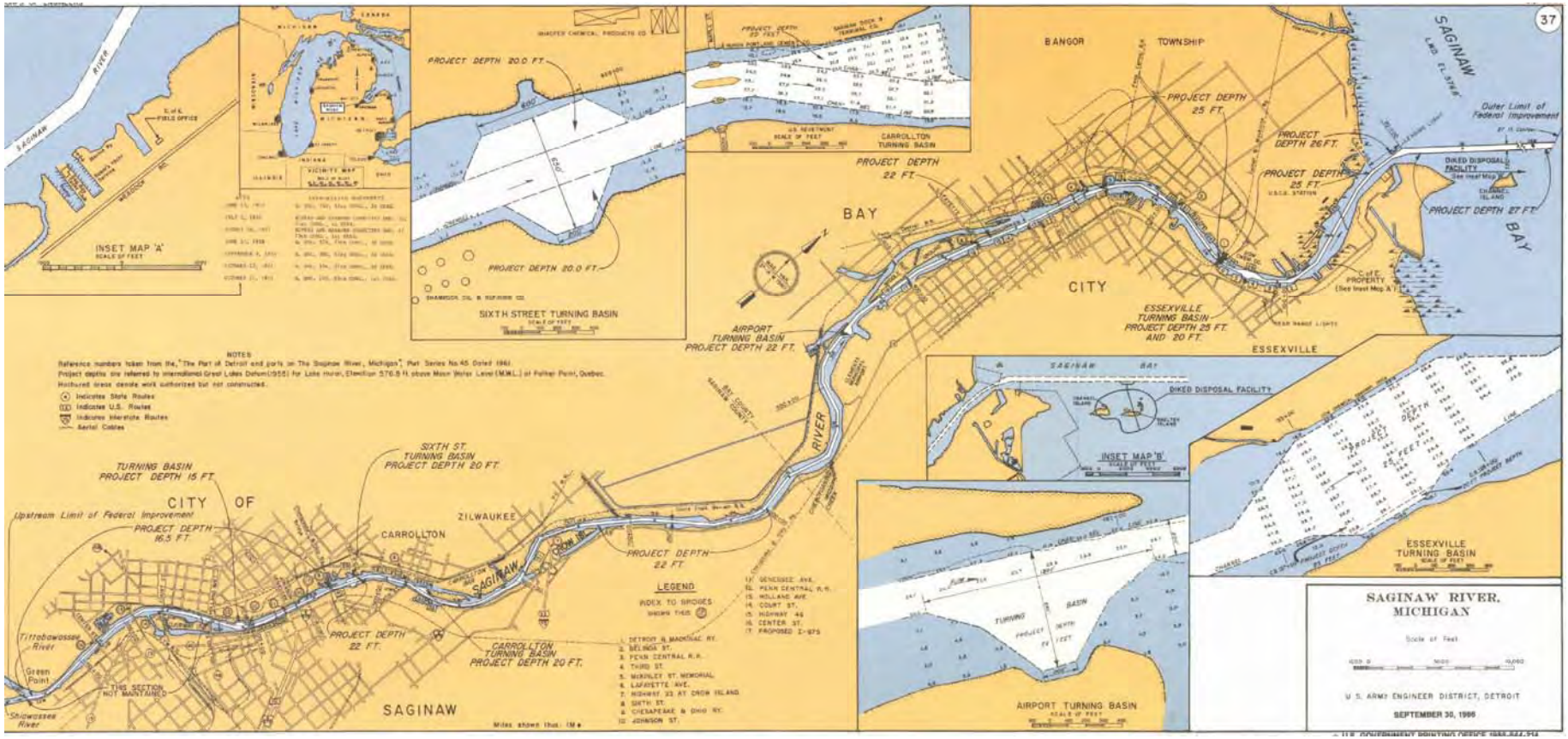

Figure 3. Map of the Saginaw River Showing the Sixth Street (and Other) Turning Basin (ca. 1987).

3. FIELD PROCEDURES

3.1 MOBILIZATION/DEMOBILIZATION

Pre-mobilization activities include subcontractor selection and contracting, equipment specification and procurement, and staffing and task planning. Mobilization of equipment and personnel for field sampling will be undertaken prior to commencement of field sampling activities. Personnel, supplies, equipment, and subcontractors will be mobilized and demobilized to and from the Site as necessary for completion of investigation tasks. Equipment leaving the Site may require decontamination prior to departure in accordance with the specific SOP.

3.2 SITE FACILITIES

A location for the storage and staging of equipment and land-based vehicles during the field investigation will be maintained. This location will include a decontamination area, a sample handling and preparation facility, and a storage facility. Access to this location will be strictly controlled. No one shall enter the area without appropriate authorization and health and safety training. Watercraft vessels will be moored at an appropriate nearby marina or docking area.

3.3 HEALTH AND SAFETY

Health and safety requirements applicable to all persons entering the secured location or involved in field activities on the Saginaw River will be described in a separate Health and Safety Plan (HASP).

3.4 TECHNICAL SUPPORT

Field work will be conducted or contracted and supervised by ENVIRON. Work is anticipated to require a 3-person field team, including a boat captain and 2 field technicians for sample collection, hydrographic survey, health and safety, handling/processing, and recordkeeping of all aspects of the field work.

4. FIELD TASKS

4.1 TASK 1 – ESTABLISH MONITORING TRANSECTS

Field work for Tasks 2 and 3 will consist of characterizing surface water velocities and sediment transport at 2 river transects: 1 transect located upstream and 1 transect located downstream of the SSTB. The locations will be selected to optimize sediment and water sampling and the collection of hydrodynamic information.

Sampling and river transect locations will be selected based on the following criteria:

- Straight reaches of the river, where flow is anticipated to be relatively uniform;

- Transects situated at distance upstream and downstream from the SSTB to minimize hydrodynamic influences of the turning basin itself;
- The reach between the two transects excludes (to the extent possible) major flow and solids inputs directly into the river;
- Shore-to-shore distance across the river to support a reasonable level of monitoring;
- Transects with minimal or no shoreline access restrictions; and,
- Transects that minimize interference with boat traffic, to the extent possible.

The proposed locations of both river transects are tentatively identified in Figure 4 (tentative transect locations). The actual position of sampling locations and transects may change in the field based on site-specific observations and unexpected conditions or shoreline access restrictions, as well as updated information on recent SSTB dredging efforts. The final sampling locations and river transect positions will be surveyed using global positioning system (GPS).

4.2 TASK 2 – SHORT-TERM HYDRODYNAMIC SURVEYS

4.2.1 Data Needs and Investigation Objectives

Short-term hydrodynamic surveys include the following:

- 1 dry-weather survey conducted during the fall of 2006;
- 1 wet-weather survey conducted during the spring of 2007 during "bank-full" flow conditions (approximately 10,000cfs, typically during the period of peak spring thaw); and,
- 1 wet-weather survey conducted during the spring of 2007 during moderate high-flow conditions (approximately 5-8,000cfs, typically during early or late spring thaw).

The short-term dry-weather survey in fall 2006 is intended to provide data on baseline sediment transport under relatively low-flow river conditions. These data will make it possible to describe baseline mass flux into and out of the turning basin, and to provide an estimate of the mass retained in the basin under these conditions. Observations made regarding the cross-sectional heterogeneity of measured parameters also will be useful for designing the subsequent wet weather (high-flow) hydrodynamic surveys.

The short-term wet-weather surveys in spring 2007 are intended to collect information over a range of moderate to high river flow conditions to determine the degree of associated variation in suspended sediment and contaminant loads. More detailed sampling of the water column during wet-weather events will provide a characterization of the changing suspended sediment load and D/F concentrations under high-flow conditions.

To accomplish these objectives, the hydrodynamic survey team will deploy and recover a suite of in-situ recording instruments, which will document surface water elevations, current velocity, suspended sediment load, and suspended solids distribution in the Saginaw River, upstream and downstream of the SSTB. Additional characterization data (i.e., temperature, pH, and dissolved oxygen levels) will be collected for general characterization of river water quality.

4.2.2 Short-Term Dry-Weather Survey - Methods and Equipment Specifications

The hydrodynamic survey team will use both in-situ and boat mounted monitoring equipment. River surveys will be conducted by a 3-person team consisting of a senior Project hydrographer, a junior hydrographic engineer, and a field technician aboard a survey vessel.

Positioning of the survey vessel will be achieved through use of Differential GPS using a Trimble Geo XT receiver and USCG corrections. Geodetic data will be viewed in real time on the Trimble Geo XT which will display the target trackline and vessel position. The GeoXT also will be used to track and store data coordinating all collected samples with time and spatial coordinates.

The real-time boat-mounted survey will consist of surveys of river current velocities, temperature, and turbidity, and suspended sediment concentrations and particle size distributions at different water depths using boat-mounted monitoring equipment. Temperature and turbidity measurements will be made using a Hydrolab data sonde or equivalent. River velocities will be measured using an Acoustic Doppler Current Profiler (ADCP). River water samples will be collected concurrently to provide samples for analysis of total suspended solids and suspended sediment concentrations, particle size distribution (laser diffraction method), total organic carbon and D/F concentrations. Results of the water column sampling will be used to develop correlations between velocity, turbidity, total suspended solids/suspended sediment, and D/F concentrations in the suspended solids.

Current Velocity Monitoring: The real-time current velocity structure of the Saginaw River will be established using a boat-mounted RD Instruments 1,200 kHz Acoustic Doppler Current Profiler (ADCP) (or similar unit). The ADCP unit is used to map the flow of the river in real-time as the survey vessel is maneuvered along a series of cross-river transects. The data are uploaded and displayed on the navigational computer in real-time, allowing the field crew to observe a two-dimensional map of the flow distribution, allowing for real-time data quality checking. To collect data, the survey team will pilot the survey vessel across the river while at the same time collecting current velocity profiles of the water column. Current velocity data will be compiled with a vertical resolution of ½ -meter and a horizontal resolution of 5 meters (the resolution may change depending on real-time observations in the river). Each transect will be repeated hourly (nominally) over an 8-hour day to capture a range of flow conditions over an 8-hour period. The boat-mounted ADCP data will be reduced to ASCII listings of current speed and direction versus depth and x/y position. In addition, the current information will be presented as vertically-averaged current vector plots for each survey.

Suspended Sediment and Turbidity Profiling: Concurrent with the ADCP profiling, the survey team will collect density and turbidity profiles of the river. This will be accomplished using a SeaBird SBE 19 SeaCat CTD-Turbidity profiler, an optical back scatter (OBS) meter to measure suspended solids concentrations, and a Laser In-Situ Scattering and Transmissometry (LISST-100) to measure in-situ particle size distribution. The profiles will be repeated in parallel with the ADCP, once per hour over an 8-hour day, to document the spatial variations in temperature, density, and turbidity, and particle size distribution (PSD), and to correlate relationships between turbidity, suspended solids concentration, and PSD. The real-time CDT-OBS-LISST profiling will be processed and presented as profiles of conductivity (mS/m),

temperature (ºC), turbidity (NTU), and suspended solids concentration vs. depth (feet) per transect per profiling round. All data will be available as ASCII computer listings.

In addition, pH, and dissolved oxygen levels will be measured for general characterization of river water quality using a Hydrolab datasonde or equivalent.

Bed Load and Sediment Deposition Measurements: Sediment bedload transport rates will be measured using a Helley-Smith bedload sampler deployed from a moored boat. Bedload will be monitored at discrete intervals along the upstream and downstream SSTB transects to provide estimates of near-bed transport at locations upstream and downstream of the turning basin. The volume of collected material will be quantified, and samples will be retained for laboratory submission as required for dioxin/furan analysis.

Sediment traps (approximately 2 ½-inch diameter trap opening) will be deployed at discrete intervals along the upstream and downstream transects, and along three transects within the turning basin. The deployed traps will provide a measurement of gross sedimentation rate at each location, representing conditions upstream of the basin, the leading, middle, and trailing end of the basin, and downstream of the basin. Traps will be deployed flush with the sediment bed, to provide an accurate and representative measurement of the gross deposition rate collected at the sediment-water interface. Sediment trap deployment period and trap aperture size will be adjusted during the investigation to provide a representative measurement of deposition rate and an appropriately sized sample of deposited material. The volume of collected material (approximately 10 g) necessary to achieve required analytical detection limits will be confirmed prior to sample collection, and samples will be retained for laboratory submission as required for D/F analysis.

Surface Water Sampling: Unfiltered river water samples will be collected to measure turbidity, suspended solids, and suspended sediment concentrations at the same time turbidity and suspended solids concentrations are measured using CTD, OBS, and LISST-100 equipment. At each water sampling transect, composite samples will be collected using depth-integrated equal-discharge-increment (EDI) methods. Each sample will be composited from equal water volumes obtained from 3 pre-determined sampling stations that represent equal-discharge increments across the river. This ensures that water samples optimally represent each transect. River water samples will be tested in the laboratory to determine total suspended solids/suspended sediment concentrations; particle size distribution (using a laser diffraction method); D/F congener concentrations (provided sufficient mass of material can be collected) using Method 1613B; total organic carbon (TOC) using EPA Method 9060A (or similar); and, black carbon according to Gustavson et al. 1997 (*Environ. Sci. Technol*., 31:203-209).

Suspended solids samples will be analyzed for D/F using 2 analytical methods: Method 1613-TRP/RT and Method 1613B. Method 1613-TRP/RT is Dow's *Rapid Turnaround Analysis*, which modifies Method 1613B by using a subset of site-specific D/F congeners that represent the dominant fraction (more than 90%) of D/F mass in the Saginaw River. Method 1613B analyzes for all 17 2,3,7,8-substituted D/F congeners. Sample extraction, including internal/surrogate standards, is identical for both methods. Both methods are described in detail in the *GeoMorph SAP* (ATS, 2006) and are included in this SAP by reference. Method 1613-TRP/RT measures the following D/F congeners:

- 2,3,7,8-TCDF
- 2,3,7,8-TCDD
- 1,2,3,7,8-PeCDF
- 2,3,4,7,8-PeCDF
- 1,2,3,4,7,8-HxCDF + 1,2,3,6,7,8-HxCDF

All samples will be analyzed using Method 1613-TRP/RT. Sample extracts will be stored for further analysis pending D/F concentration results. A subset (10%) of the sample extracts will be analyzed for the full suite of 17 2,3,7,8-substituted D/F congeners using Method 1613B. The samples will be selected based on concentration, vertical D/F distributions in the sediment cores, and to match samples identified for the fractionation study.

Surface Water Elevation Monitoring: Surface water elevations will be monitored using an in-situ pressure sensor. The gauge will be located at the Johnson Street bridge crossing just upstream of the study area, and will be vented to the atmosphere to allow for real-time compensation for variations in atmospheric pressure. The gauges will be set to record data at the same time intervals used by the USGS gauge located at the Rust Avenue Bridge. These levels will be referenced to the International Great Lakes Datum (IGLD 85). Gauges will be surveyed to a vertical reference point on the Johnson Street Bridge. Surface water gauges will be installed at the beginning of the study so that levels can be monitored continuously throughout the duration of the study.

4.2.3 Short-Term Wet-Weather Surveys - Methods and Equipment Specifications

It is hypothesized that a significant majority of the solids load conveyed from the Tittabawassee River to the Saginaw occurs under high-flow conditions created by wet weather events or during spring snowmelt. High flow conditions and sediment transport conditions are dynamic, and the amount (load) and type (particle size distribution) of sediment conveyed by the Saginaw River changes significantly under high flow conditions.

Monitoring of the turning basin area will be similar to monitoring conducted under dry-weather conditions and will include documenting surface water elevations, current velocity, suspended sediment load, and suspended solids distribution in the Saginaw River, upstream and downstream of the SSTB. Additional characterization data (i.e., salinity, temperature, pH, and dissolved oxygen levels) will be collected for general characterization of river water quality. Sampling of the river during the event will be conducted to capture the rise of the event, the event peak, and two rounds of sampling to capture the tail of the event as flows return to normal conditions.

The hydrodynamic survey team will use both in-situ and boat mounted monitoring equipment. River surveys will be conducted by a 3-person team consisting of a senior Project hydrographer, a junior hydrographic engineer, and a field technician aboard a survey vessel.

Positioning of the survey vessel will be achieved through use of Differential GPS using a Trimble Geo XT receiver and USCG corrections. Geodetic data will be viewed in real time on a Trimble Geo XT which will display the target trackline and actual vessel position. The GeoXT will also be used to track and store data coordinating all collected samples with time and spatial coordinates.

The real-time boat-mounted survey will consist of surveys of river current velocities, temperature, and turbidity, and suspended sediment concentration/particle size distribution at different water depths using boat-mounted monitoring equipment. Measurements will be made using SeaBird SBE 19 SeaCat CTD-Turbidity profiler, an optical back scatter (OBS) meter to measure suspended solids concentrations, and a Laser In-Situ Scattering and Transmissometry (LISST-100) to measure in situ particle size distribution. River velocities will be measured using an Acoustic Doppler Current Profiler (ADCP). River water samples will be collected concurrently to provide samples for analysis of total suspended solids/suspended sediment concentration, particle size distribution (laser diffraction method) and D/F concentrations.

Results of the water column sampling will be used to develop correlations between velocity, turbidity, total suspended solids/suspended sediment, and D/F concentrations. Specific methods for current velocity monitoring, suspended sediment and turbidity profiling, bed load measurements, surface water sampling, and surface water elevation monitoring are as described previously for the dry-weather survey.

These measurements will be supplemented with automated water sampling at the upstream and downstream transects. These water samples will be analyzed for suspended sediment concentrations and will be used to provide information on how suspended sediment concentrations change over the dynamic conditions of a wet-weather event. Automated water sampling will be conducted with an ISCO-type sampler (or equivalent). The ISCO sampler is an automated peristaltic pump sampling system that collects samples at a preset interval and delivers samples to a series of bottles contained in the sampling device. The ISCO sampler intake will be co-located with the OBS in-situ devices, providing samples representative of the typical solids conveyance.

4.3 TASK 3 – LONG-TERM HYDRODYNAMIC SURVEY

4.3.1 Data Needs and Investigation Objectives

As described in Section 2.2, the long-term survey is intended to provide data on river flow and solids fluctuations over time, monitoring for seasonal variability in sediment load and transport characteristics using in-situ sensing equipment.

The long-term monitoring program includes a combination of in-situ monitoring and boat- and bridge-based sampling activities over a period of approximately 3 months. The hydrodynamic survey team will deploy a suite of in-situ recording instruments for the duration of the monitoring period, which will document the surface water elevations, current velocity, suspended solids/sediment load, and suspended solids distribution in the Saginaw River, upstream and downstream of the SSTB. Additional characterization data (i.e., temperature, pH, and dissolved oxygen levels) will be collected for general characterization of river water quality.

4.3.2 Long-Term Wet-Weather Survey - Methods and Equipment Specifications

Current Velocity Monitoring: Current velocities will be measured at each of 2 transect locations, plus 1 location in the SSTB. The velocity measurements will be collected using bottom-mounted Acoustic Doppler Profilers (ADP), which provide average channel velocities by

measuring a broad spectrum of current velocities at different water depths. The ADPs will be deployed on the river bed, near the center of the river (to the extent practicable), in an upward/outward looking position, and will be set to record velocity data at 15-minute intervals.

Suspended Solids and Turbidity Profiling: At each survey transect, in-situ total suspended solids concentrations will be measured using OBS gauges. The gages will be located near the center channel (to the extent practicable), at a location identified as representative of the conveyance of sediment as identified under Task 1. The OBS gauges will positioned at near bottom, at mid-depth, and at near surface. The near surface instrument will be deployed on a surface buoy to maintain a near surface position as water levels change with time. The 3 instruments will be set to record data at 15-minute intervals.

Surface Water Elevations: Surface water elevations will be monitored using an in-situ pressure gauge mounted on the Johnson Street Bridge. The gauges will be set to record data at the same time intervals used by the NOAA or USGS gauge network in the river. As the tide gauges record total pressure, the data record must be corrected for variations in barometric pressure. Local barometric pressure data will be collected from the National Weather Service Office located either at the TriCity Airport or Detroit Airport for the necessary adjustments to provide actual water levels. These levels will be referenced to the International Great Lakes Datum (IGLD 85) vertical datum such as NOAA Mean Lower Low Water Datum (MLLW) or other appropriate datum for the Saginaw River. Gauges will be surveyed to a vertical shoreline reference point.

4.4 TASK 4 – BATHYMETRIC SURVEYS

Bathymetric surveys will be conducted under the direction of an ACSM certified hydrographer. The hydrographic survey will be conducted in accordance with the US Army Corps of Engineers' "*Engineering Manual EM 1110-2-1003 for Hydrographic Surveys*" for navigation and dredging support in soft bottom materials.

The survey team will be equipped with a Trimble DGPS vessel positioning system, trackline control and data logging system, and a multibeam bathymetry survey meter. The survey team will make a good faith effort to collect soundings from "bank to bank" at times of high water. However, shoreline obstructions may limit bank-to-bank coverage in some areas.

Horizontal control for the project will be established from USACE monuments located along the banks of the Saginaw River. Using these monuments, additional control stations using standard land surveying techniques may be established. Upon completion of the survey, the soundings will be corrected to the project datum and referenced to the Michigan State Plan Coordinate System. Horizontal control information will be shown on all drawings and charts produced.

Surface water elevation records will be acquired by recording water levels at 2 in-situ water level gauges installed on the river throughout the periods during which sounding measurements are collected. Soundings will be adjusted to the International Great Lakes Datum based on a linear interpolation of tidal heights between the 2 gauges.

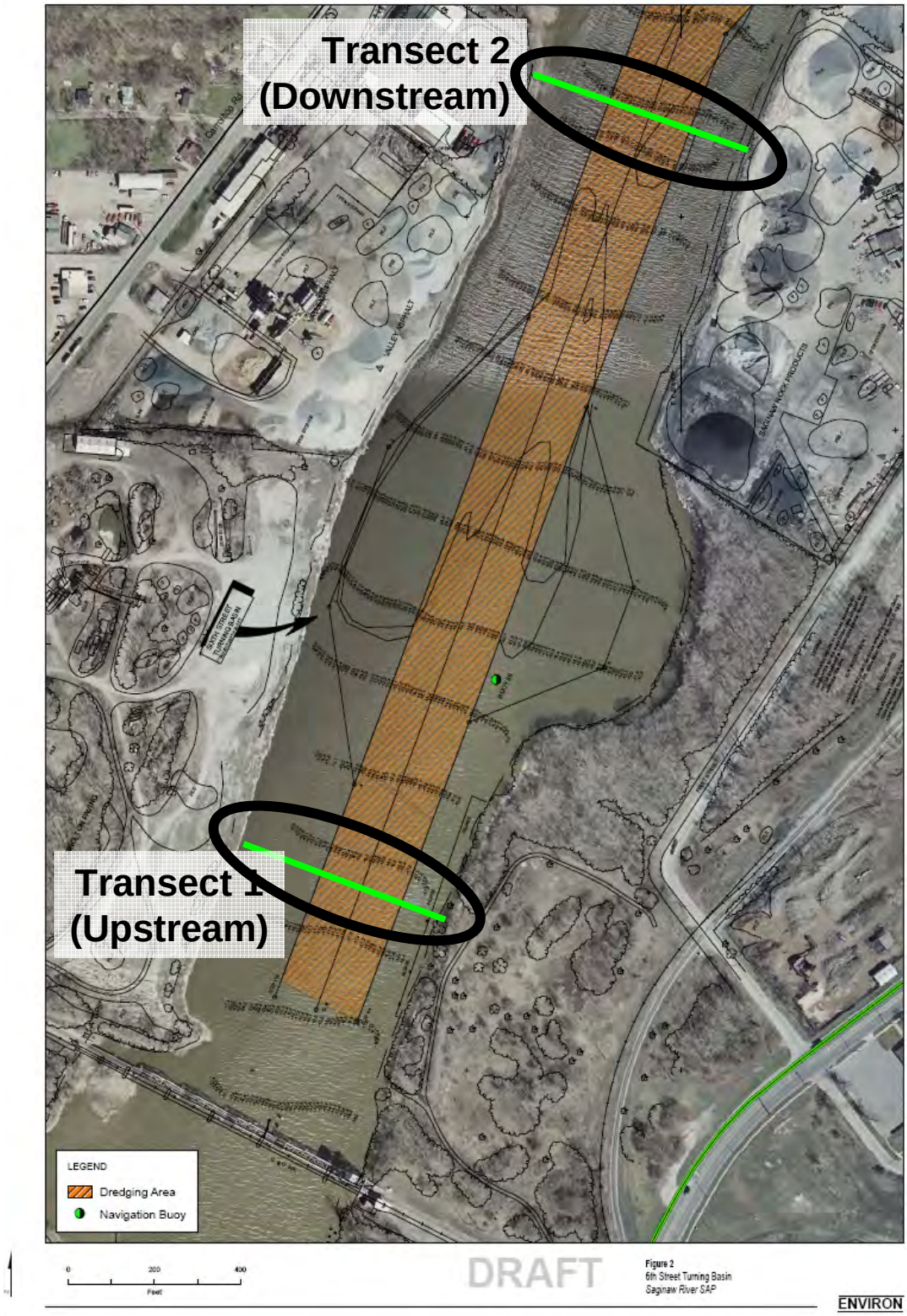

Figure 4. Tentative Field Transect Locations for the Sediment Trap Study.

5.0 DATA MANAGEMENT

Unique sample identification codes will be assigned to each field sample collected during the short-term and long-term surveys. Samples will be documented and tracked using appropriate chain-of-custody procedures. Samples will be tracked from collection to final disposal.

Sampling and analytical/physical testing records will be maintained by the ENVIRON project manager. Electronic copies of field notes will be generated to establish a permanent record.

Validated chemical analytical data will be entered into a project database. Field, analytical, and other data will be stored in the project files in hard copy form, in accordance with ENVIRON's document retention policy.

Each data package received from the laboratory will be validated to assess compliance with the appropriate Quality Assurance Project Plan (QAPP). A QA review report will be prepared as part of data validation describing any lapses in established protocols or accepted QC parameters and the potential data quality impacts. Data qualification "flags" will be applied by the laboratory for data that do not meet quality criteria.

6.0 REPORTING

ENVIRON will prepare a summary report of the data and findings. This report will include all data, QA/QC results, data summaries, and statistical analyses. The report also will include a narrative that will discuss the findings and their potential impact on the sediment trap study (Study #2) to assess the feasibility of sediment traps for long-term management of downstream sediment transport.